ACHIEVEMENTS +FUTURE FOCUS

COAL21 FUND

The COAL21 Fund is the cornerstone of the Australian black coal industry's investment in the demonstration of low-emissions coal technologies. Established in 2006, and based on a voluntary levy on coal production, it is a globally unique vehicle. This booklet sets out the good progress the Fund has made towards demonstrating low-emissions coal technologies over the past ten years, and outlines the Fund's plans for the next ten years to 2027.

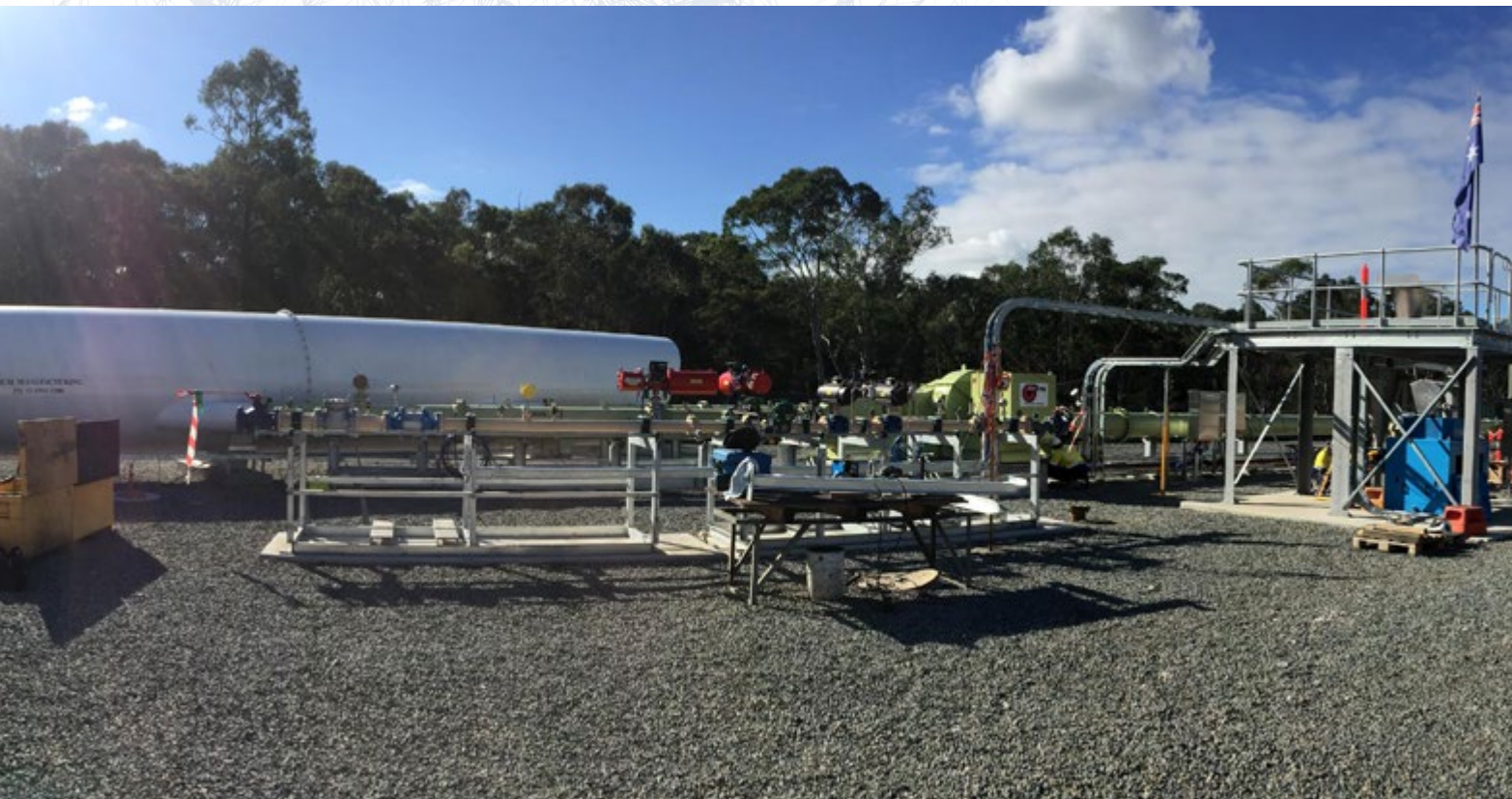
The Australian government has earmarked Carbon Capture and Storage (CCS) for inclusion in its energy policy mix.

The COAL21 Fund has invested $300m in ten years of research and development into low-emission technologies in the coal-fired power generation sector, and in fugitive emissions abatement from coal mining operations.

This research has achieved many successes including identification of geological sites suitable for CO_2 storage, assessments of the technical and financial viability of CCS technologies, and progress in the safe deployment of ventilation air methane (VAM) abatement technology.

The COAL21 Fund has received new investments of $255m to fund a further ten years of CCS research and development in Australia.

27 Australian coal producers have invested in the fund.



BACKGROUND

- World energy demand forecasts indicate that coal will continue to play a significant role in energy supply.
- The COP21 meetings in Paris reached broad consensus that global temperature rise from human-induced climate change should be limited to 2°C. This target requires deep cuts in global CO_2 emissions.
- Achieving these cuts at the lowest possible cost requires use of fossil fuels, including coal, with CCS.
- The COAL21 Fund was established in 2006 to invest in research and pre-commercial demonstration of low-emission technologies in the coal-fired power generation sector, and in fugitive emissions abatement from coal mining operations.
- The Fund's objectives are to:
  - build community confidence in CCS technology for safe, long-term CO_2 storage
  - demonstrate safe abatement of fugitive emissions from coal mines.

A PROVEN TECHNOLOGY

- seven carbon capture and storage demonstration projects underway in Australia
- 17 large-scale projects underway elsewhere in the world using the technology on a commercial basis

Achievements to date

- delivered world's first industrial-scale demonstration of oxyfuel combustion and carbon capture technology
- identified the Surat Basin in Queensland as prospective for an industrial-scale CCS demonstration between 2020 and 2025
- gained better understanding of the costs and benefits of CO_2 capture options
- identified PCC as the leading technology for deployment between 2025 and 2030 as it is the most technically advanced capture technology
- identified oxyfuel as viable technology and may be preferred for deployment at some locations between 2030 and 2050
- progressed research into safe deployment of VAM abatement technology at underground coal mines, establishing functional safety requirements for connecting ductwork, and started system design and component testing.

FUTURE FOCUS

- advance geological storage of CO_2, with PCC as the preferred capture option in the short term and oxyfuel a valuable option in the longer term
- deliver an industrial-scale CCS demonstration by 2025 through extension of the current CTSCo project. The demonstration would use the geological storage site identified in Queensland's Surat Basin and a commercial PCC module to capture CO_2 at a nearby power station.
- conduct high-level estimates of storage capacity in NSW and Queensland basins to complement the demonstration in the Surat Basin.
- demonstrate the safe abatement of fugitive methane from coal mines, by completion of the current projects with a follow-on project if required.

CURRENT PROJECTS

Photo courtesy of Coal Innovation NSW

CTSCO PROJECT

Objective

To demonstrate the technical viability of geological storage of CO_2 in Queensland's Surat Basin.

Status

- undertaking feasibility study and detailed engineering design for injecting 60,000 - 120,000 tonnes of CO_2 annually into the Surat Basin, and building of a modular CO_2 capture plant using PCC technology, sized to provide necessary volume of CO_2 to be fitted to a nearby coal-fired power station.
- completed 3D seismic surveys and identified the target geological storage reservoir within a Glencore lease near Wandoan in Queensland.
- building and maintaining local community support for the project.

Future focus

On completion of the project's current stage in 2019, it is planned to proceed to construction and operation stage.

QLD STORAGE ASSESSMENT

Objective

To complement the CTSCo Project by identifying and assessing other potential geological storage sites in the Surat Basin and providing an estimate of the basin's geological storage capacity.

Status

Undertaking site assessments using existing data from gas exploration and new data acquired from exploration wells.

Future focus

Undertake further pre-competitive exploration to increase the confidence in estimates of geological storage capacity of the Surat Basin, with possible extension to other Queensland basins.

NSW STORAGE ASSESSMENT

Objective

To identify and assess sites for the safe, long-term geological storage of CO_2 in NSW.

Status

- drilled and assessed four exploration wells in Sydney and Gunnedah Basins
- drilled two wells in the Darling Basin, west of Cobar in NSW, which show significant promise for CO_2 storage.

Future focus

Undertake further seismic surveys and drilling of additional wells to establish the lateral extent of the favourable horizon and increase confidence in estimates of geological storage capacity. The storage potential of the Darling Basin has the significant advantages of a supportive local community, no resource conflicts, and proximity to the Moomba-Sydney pipeline easement.

RESEARCH AND DEVELOPMENT SUPPORT FOR CCS DEMONSTRATION

Objective

To reduce the technology risk in CCS demonstration projects with a focus on geological storage assessment techniques and cost reduction for CO_2 capture.

Status

ANLEC R&D: researching CO_2 capture and geological storage technologies with emphasis on the underlying science of CO_2 storage, plume migration, monitoring and verification, and reaction with host rock.

CO2CRC: Otway CCS Research Facility: undertaking research at this globally recognised facility located in the Otway region of Victoria. 65,000 tonnes of CO_2 have been injected into a depleted gas field. Current research focus is on saline aquifer injection.

FUGITIVE METHANE ABATEMENT

Objective

To demonstrate safe deployment of commercially available VAM abatement technology at an Australian underground coal mine.

Status

- There are existing installations of VAM abatement technology at overseas mines but rigorous assessment and component testing is required to ensure they comply with Australian mine safety standards. Engagement with state safety regulators is critical and ongoing.
- There are two projects addressing safe deployment of existing abatement technology which are focused on functional safety requirements of connecting ductwork including system design and component testing.
- Generic functional safety requirements have been identified.
- An extensive research program has established the fundamentals of methane ignition.
- The preliminary duct design has been completed.
- The construction of a test duct at TestSafe (Londonderry) is close to completion and component testing will follow.

Future focus

When the projects are completed in 2019, an assessment will be made to determine whether safe deployment of VAM abatement technology has been demonstrated or whether further investment is required in the COAL21 Fund. There are also two other projects underway which are examining new abatement technology concepts.

COMPLETED PROJECTS

CALLIDE OXYFUEL PROJECT

Objective

To successfully retrofit oxyfuel technology to a power station boiler and operate for two years.

Results

- The two-year operational phase was completed in March 2015, achieving 10,200 hours of operation in oxy-mode against a target of 10,000 hours.
- Flexible operation was demonstrated with turn-down and ramp rate capability similar to air-firing.
- The process can be tuned to produce desired CO_2 purity between 96 and 99.8% and SOx, NOx and trace elements are inherently captured with no detrimental effects on the process.
- Oxyfuel has been established as a viable boiler retrofit option for capturing CO_2, refuting an early belief that it would be suitable for new build only.
- The final CO_2 capture and compression unit performed beyond expectations, achieving 5,600 operating hours against a target of 4,000 hours.

DELTA POST-COMBUSTION CAPTURE (PCC) PROJECT

Objective

To develop a preliminary design for a 100,000 tonnes CO_2 per year PCC plant retrofitted to an existing power station (Vales Point).

Results

Pilot scale investigations were completed to provide information on how the PCC process can be adapted to Australian conditions.

Independently of this project, PCC technology has advanced rapidly through developments by global equipment suppliers and is now offered on a commercial basis.

WANDOAN POWER IGCC FEASIBILITY STUDY

ZEROGEN IGCC FEASIBILITY STUDY

Objective

To establish a feasibility-level estimate of the capital cost for an IGCC power station with CO_2 capture, using technology from two commercial suppliers:

- GE (USA) - Wandoan Power Project
- MHI (Japan) - ZeroGen Project

Results

Contrary to initial expectations, both studies concluded that the capital costs for IGCC plant with CO_2 capture greatly exceed those for PCC and oxyfuel. IGCC was subsequently deprioritised for further investment.

CTSCO STORAGE ASSESSMENT

Objective

To conduct a preliminary appraisal of the Surat Basin in Queensland for geological storage potential in a region near existing gas production leases.

Results

This location was confirmed as offering excellent prospects for CO_2 storage and is being further developed under the current CTSCo Project.

ZEROGEN STORAGE ASSESSMENT

Objective

To conduct a preliminary appraisal of the Northern Denison Trough in Queensland for geological storage potential.

Results

The exploration drilling program established that while there were some localised pockets with useful porosity and permeability, these pockets were not sufficiently interconnected to provide a viable reservoir. The area was abandoned as a geological storage option.

KEY LEARNINGS

INTEGRATED GASIFICATION COMBINED-CYCLE (IGCC) WITH CO_2 CAPTURE

In 2006 there was a widespread view that IGCC would be the preferred power generation technology from which to capture CO_2 as it offered greater efficiency than conventional coal-fired technology and the CO_2 could be extracted at elevated pressure. The capital costs were expected to be somewhat higher than PCC and oxyfuel but were anticipated to be justified by the benefits.

Several technology providers were available and two were selected; GE (USA) and MHI (Japan). Pre-feasibility studies were conducted under the Wandoan (GE technology) and ZeroGen (MHI technology) projects for the design, construction and operation of an IGCC power station with CO_2 capture, with a view to identifying the best option.

Both pre-feasibility studies concluded that the capital costs for IGCC and CO_2 capture plants are unacceptably high. Further, advances in supercritical technology increased the efficiency of conventional coal-fired power stations which largely eliminated the benefits of IGCC. IGCC was deprioritised in favour of oxyfuel and PCC, both of which have significantly lower costs and lower operational complexity.

A great deal was learnt from these studies, all of which has been documented and will serve as a valuable reference if the use of IGCC technology is considered in the future. For example, in a power-only operation, the capital costs associated with IGCC cannot be supported, however, if demand emerges for a gasification plant that can provide feedstock for higher value products such as petrol, diesel, plastics, and fertilisers - with power as a side product - then IGCC technology would offer a fit-for-purpose solution.

COMPARISON OF PCC AND OXYFUEL TECHNOLOGIES

The capital costs for PCC and oxyfuel are similar and significantly lower than IGCC.

PCC is currently the most advanced CO_2 capture technology and is preferred for a CCS demonstration in the 2025 timeframe. It is an add-on technology for extracting CO_2 from the flue gas of an otherwise conventional coal-fired power station. It can be readily deployed in discrete modules treating a portion of the flue gas and enabling partial capture. This will allow staged reduction of CO_2 emissions over time, which may be preferred in early applications.

Oxyfuel technology, as demonstrated in the Callide Oxyfuel Project, is not as advanced as PCC and is unlikely to be commercially available prior to 2030. It does not allow partial capture as it requires conversion of the boiler to oxyfuel operation. However, it has some advantages and may be preferred at some locations in future for the following reasons:

- it has lower water requirements so is better suited for arid locations
- it requires no chemical solvents so occupational health and safety hazards are reduced
- it inherently captures SOx and NOx with no detrimental effect on the process. These gases cause significant solvent degradation problems in PCC systems.

GEOLOGICAL STORAGE STUDIES

The southern end of the Surat Basin offers commercial scale CO_2 storage opportunities but at significant depth (below 2000m). The shallower (1200m) northern end, adjacent to producing gas fields, is better suited to a demonstration project as reduced amounts of CO_2 are required (200,000 tonnes) between seismic surveys to visualise the development of the plume. Commercial-scale CO_2 storage could commence at the northern end of the basin and progressively move south as required.

A further lesson from these projects is that the search for geological storage locations requires appropriate legislation and a supportive regulatory environment. The absence of greenhouse gas legislation in Queensland at the time severely limited the storage options that could be examined.

AUSTRALIAN CCS PROJECTS


CTSCO
1 well drilled
3D seismic completed
Assessment underway
GORGON PROJECT
Commissioning underway
First injection 2017
Planned 3Mt/a
CALLIDE
Oxyfuel demonstration completed
Darwin
Northern Territory
Queensland
Western Australia
South Australia
Brisbane
New South Wales
Perth
Adelaide
Sydney
Canberra
Victoria
ACT
Melbourne
Tasmania
Hobart
PRECOMPETITIVE EXPLORATION
Underway
CO2CRC OTWAY PILOT
2C experiment underway
Phase 3 in planning
SW HUB FLAGSHIP
4 wells drilled
5th well planning
CARBONNET FLAGSHIP
Site selection completed
Appraisal underway

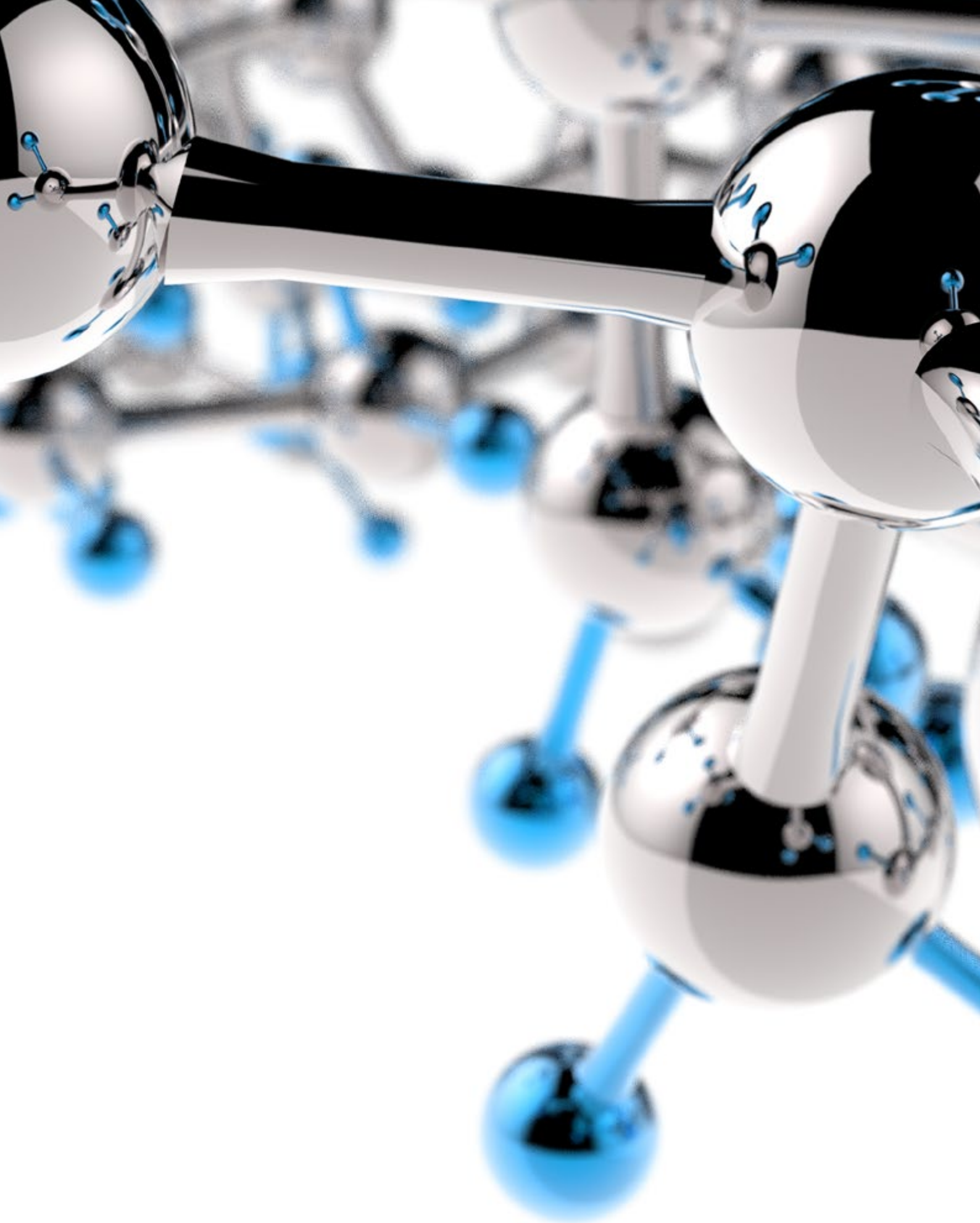
GLOBAL CCS PROJECTS

Name	Location	Operation date	Industry	CO_2 Capture (Mtpa)	Primary storage type
Terrell	United States	1972	Natural Gas Processing	0.5	Enhanced oil recovery
Enid Fertilizer	United States	1982	Fertiliser Production	0.7	Enhanced oil recovery
Shute Creek	United States	1986	Natural Gas Processing	7.0	Enhanced oil recovery
Sleipner	Norway	1996	Natural Gas Processing	1.0	Dedicated Geological Storage
Great Plains Synfuels	Canada	2000	Synthetic Natural Gas	3.0	Enhanced oil recovery
Snøhvit	Norway	2008	Natural Gas Processing	0.7	Dedicated Geological Storage
Century	United States	2010	Natural Gas Processing	8.4	Enhanced oil recovery
Air Products	United States	2013	Hydrogen Production	1.0	Enhanced oil recovery
Coffeyville Gasification	United States	2013	Fertiliser Production	1.0	Enhanced oil recovery
Lost Cabin	United States	2013	Natural Gas Processing	0.9	Enhanced oil recovery
Petrobras Santos	Brazil	2013	Natural Gas Processing	1.0	Enhanced oil recovery
Boundary Dam	Canada	2014	Power Generation	1.0	Enhanced oil recovery
Quest	Canada	2015	Hydrogen Production	1.0	Dedicated Geological Storage
Uthmaniyah	Saudi Arabia	2015	Natural Gas Processing	0.8	Enhanced oil recovery
Abu Dhabi CCS	United Arab Emirates	2016	Iron and Steel Production	0.8	Enhanced oil recovery
Illinois Industrial CCS	United States	2017	Chemical Production	1.0	Dedicated Geological Storage
Petra Nova	United States	2017	Power Generation	1.4	Enhanced oil recovery
			TOTAL	31.2	

CURRENT AND COMPLETED PROJECTS TO JUNE 2017

Projects - Complete	Objective
ZeroGen IGCC with CCS	Feasibility study for a power station using MHI IGCC and capture technology with storage in Northern Denison Trough (Qld)
Wandoan Power	Feasibility study for a power station using GE IGCC & capture technology
CTSCo Feasibility	Feasibility study for geological storage in Surat Basin (Qld)
Callide Oxy-fuel Project	Demonstration of oxyfuel technology retrofitted to 30MWe power station in Qld
Delta PCC Project	Preliminary design of a 100,000 tpa PCC plant and characterisation of a geological storage site in NSW

Projects - Current	Objective
CTSCo Project	Full engineering design for commercial scale geological storage in Surat Basin (Qld) and PCC capture plant module at a nearby power station, with potential to be developed into a fully integrated demonstration of CO_2 capture, transport and storage
Qld Storage Assessment	Collect geological data in known Qld basins to identify prospective areas to search for geological storage
NSW Storage Assessment	Collect geological data in known NSW basins to identify prospective areas to search for geological storage
ANLECR&D	R&D to support CCS demonstration projects and test concepts for longer term improvements
CO2CRC / Otway Storage	Larger scale geological storage research using the Otway research facility (Victoria)
Fugitive Methane Abatement	Suite of projects addressing safe deployment of commercially available technology for the abatement of fugitive methane emissions from underground coal mines

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